

FUNDAMENTALS OF CHEMISTRY 1A (CHEM1001) - June 2012

2012-J-2

- Ca_3N_2
 CBr_4
iron(III) oxide
 H_2SO_4

- Many elements consist of isotopes, *i.e.* atoms with different numbers of neutrons and hence different atomic masses. The atomic mass of each isotope is close to an integer value. The relative atomic mass of an element is calculated using all these different isotopic masses and their relative percentages.

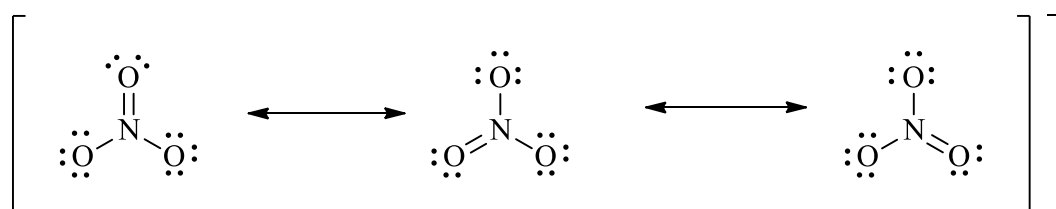
- U_3O_8

2012-J-3

-

	yes
	no
	yes
	yes

- When two or more Lewis structures can be drawn for a molecule, the true structure is none of the structures that is drawn, but a type of average made up of all the resonance contributors. Some structures may contribute more than others.



e.g. In NO_3^- , the ion does not contain 1 double and 2 single bonds, but is an average of the three structures shown. All of the N-O bonds are exactly the same length and the energy of the true structure is lower than the theoretical energy for any one of the given structures. This energy difference is known as resonance stabilisation energy.

2012-J-4

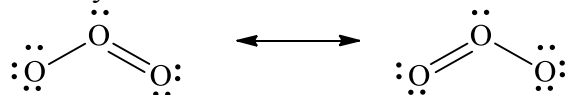
- $4\text{NH}_3(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
88.2 g
- A stream of positively charged alpha particles was fired at a thin sheet of gold foil. Most of the particles passed straight through or were slightly deflected, but the occasional one was reflected back towards the source. The conclusion drawn was that atoms consist of mostly empty space with a small, dense, positively charged nucleus.

2012-J-5

- | | | |
|----|---|------|
| 2 | 1 | 0 |
| 2 | 2 | 1 |
| 10 | 3 | 2 |
| 8 | 2 | 0, 1 |



Ozone adopts the non-cyclic structure. The cyclic structure is very strained with bond angles of 60° instead of 109.5° , making it very unstable. In contrast, the second structure is stabilised by resonance.



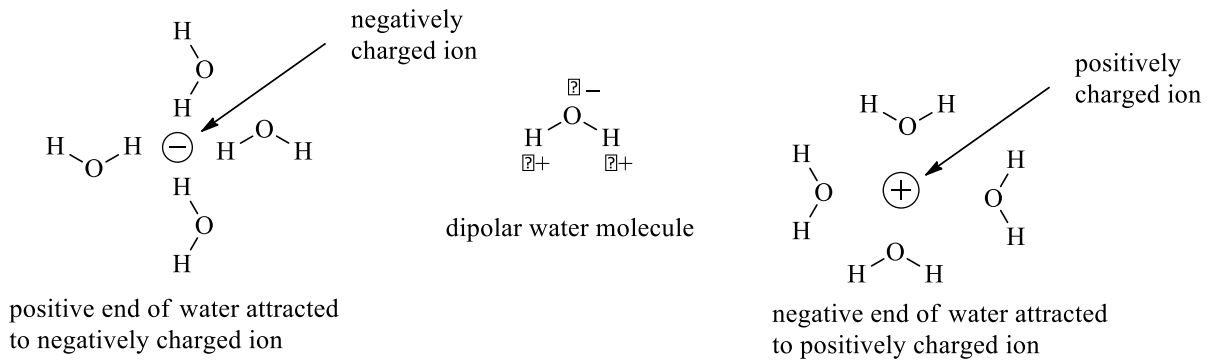
Ozone does not contain 1 double and 1 single bond. Both the O-O bonds are exactly the same length and true structure is a sort of average of the two Lewis structures shown. The energy of the true structure is lower than the theoretical energy for either of the given structures. This energy difference is known as resonance stabilisation energy.

2012-J-6

- 1s orbital is smaller, closer to the nucleus, has a lower energy and has 0 nodes.
2s orbital is larger, further from the nucleus, has a higher energy and has 1 node.
Both orbitals are spherical.
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
 $1s^2 2s^2 2p^6 3s^2 3p^6$
 $1s^2 2s^2 2p^6 3s^2 3p^6$

2012-J-7

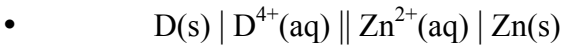
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Water is a dipolar molecule. The positive ends (H) can directly interact with negative ions, while the negative end (O) can directly interact with positive ions. These interactions (called hydration enthalpy) are often sufficient to overcome the lattice enthalpy (the energy required to break up the ionic solid into its constituent ions).

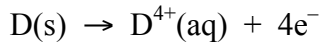
- 130 g (to 2 significant figures)

2012-J-8

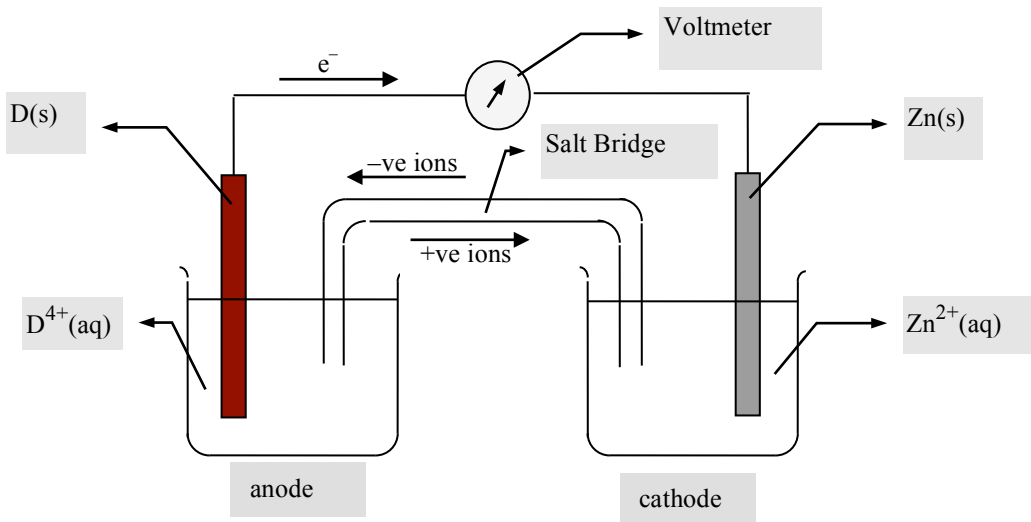


Yes. E° is positive and hence ΔG° is negative.

D



-0.94 V



2012-J-9

- 28.8 °C
- 2000 C (to 1 significant figure - calculator gives value of 2400)
0.01 mol
0.3 L

2012-J-10

- 2.05 mol

2012-J-11

- $\text{CH}_4 < \text{CH}_3\text{CH}_3 < \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3 < \text{CH}_3\text{OH} < \text{CH}_3\text{CH}_2\text{OH}$

Only weak dispersion forces act in CH_4 and CH_3CH_3 . The bigger molecule has more interactions and hence the higher b.p. $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ is a bigger molecule than CH_4 and CH_3CH_3 , so has more dispersion forces. It also has dipole-dipole forces due to the polarised C-O bonds. CH_3OH and $\text{CH}_3\text{CH}_2\text{OH}$ have hydrogen bonds due to the very electronegative O atom bonded to the H atom. These H-bonds are much stronger than the dispersion and dipole-dipole forces in the other compounds and hence these two compounds have the highest boiling points. $\text{CH}_3\text{CH}_2\text{OH}$ has more dispersion forces than CH_3OH , so it has the highest boiling point.

- There are two competing intermolecular forces at play. Dipole-dipole forces increase as the halogen becomes more electronegative ($\text{I} < \text{Br} < \text{Cl} < \text{F}$). Dispersion forces are dependent on the polarisability of the atoms and increase with the size of the halogen. This is the dominant force in HCl , HBr and HI and determines the order of their melting points. The dipole-dipole force in HF is so strong (due to the very small and very electronegative F atom) that it is given a special name - a hydrogen bond. This causes HF to have an anomalously high melting point, which just happens to lie between that of HBr and HI .

2012-J-12

- 93 kJ mol^{-1}
47 kJ mol^{-1}
349 kJ mol^{-1}

Each N atom in hydrazine has a lone pair of electrons and is the negative end of a dipole formed with the H atoms. (Hydrazine has a high b.p. due to the H-bonds that it forms.) These negatively charged N atoms slightly repel each other which weakens the bond between them.